AGIMUS

WHITEPAPER

Best Practices, Lessons Learnt and Recommendations

for the design and deployment of AI-powered versatile robotics in agile production

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Purpose of this whitepaper

This document consolidates evidence-based best practices, project lessons and actionable recommendations emerging from AGIMUS stakeholder research, pilot-linked industrial case studies, technology-development experience and exploitation planning. It is intended to support knowledge transfer beyond the project and to provide a practical reference for researchers, technology providers, industrial adopters, integrators and policymakers.

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Executive summary

AGIMUS addresses the transition from task-specific industrial automation towards more versatile, adaptive and AI-enabled robotic systems for agile production. The project Grant Agreement explicitly foresees the provision of best practices, lessons learnt and recommendations through whitepapers to support knowledge transfer and European excellence. This whitepaper responds directly to that objective by translating the project's evidence base into deployment-oriented guidance.

The central lesson is that versatile robotics must be treated as a sociotechnical system. Technical capability is necessary, but industrial uptake also depends on reliability, maintainability, integration readiness, data governance, human oversight, workforce acceptance, organisational preparation and a credible pathway for long-term support. AGIMUS stakeholder research found reliability, maintainability, increased accuracy and adaptability to be core technical priorities, while technical robustness and safety, privacy and data governance, and transparency were perceived as comparatively difficult requirements. Workforce resistance was associated particularly with job-security, role-change and perceived loss of professional value, whereas clear communication, training, workforce-retention planning and comprehensive briefing on the scope of implementation received strong support as acceptance measures.

Key message

Do not evaluate versatile robotics only by whether a robot can perform a task. Evaluate whether it can perform the task reliably, repeatedly, safely, maintainably and transparently in the target production environment — and whether the organisation and workforce are prepared to use it.

At a glance: the AGIMUS evidence base

Evidence stream	AGIMUS basis	Contribution to this whitepaper
Desk research	Scientific, industrial and policy literature on agile manufacturing, robotics and trustworthy AI	Initial requirements, barriers, drivers and enablers
Expert interviews	22 interviews: 20 technical/industrial stakeholders and 2 external ethics experts	Refinement of technical, ethical and organisational requirements
Industrial case studies	Aircraft & satellite manufacturing, lift manufacturing and packaging manufacturing	Grounding in realistic production tasks and constraints
Stakeholder survey	180 analysed respondents from 16 European countries; March 2023 baseline	Prioritisation of needs, barriers, challenges, drivers, enablers and acceptance measures
Project implementation & exploitation planning	Open-source software development, integration planning, validation activities and sustainability planning	Lessons on interoperability, documentation, support, governance and post-project uptake

Evidence note: the quantitative survey was conducted in March 2023 and should be interpreted as a baseline rather than as a current 2026 market measurement. The paper itself does not report final technical performance of the AGIMUS robotic system.

1. Best practices for trustworthy and industrially feasible deployment

The following practices synthesise the project's technical, industrial, ethical and organisational evidence. They are intended as reusable deployment principles rather than as application-specific engineering specifications.

1. Start from the production problem, not the robot capability. Define the target task, product variability, accuracy tolerance, cycle-time expectations, safety constraints, maintenance needs and integration interfaces before selecting or optimising the robotic capability. Pilot-linked case studies showed that practical constraints such as accuracy, maintainability and safety can be missed by abstract technology-driven planning.

2. Treat reliability and maintainability as adoption prerequisites. A versatile system that performs an impressive task once but cannot sustain dependable performance creates production risk rather than agility. Validation should include repeatability, recovery from errors, maintenance effort, downtime exposure and operator intervention — not only task completion.

3. Design for modularity, interoperability and change. Separate capabilities into replaceable modules with clear interfaces wherever feasible. Industrial environments are heterogeneous and often contain legacy hardware and software; modular architectures make upgrades, integration and platform adaptation more manageable.

4. Translate ethical requirements into engineering controls. Privacy, transparency, accountability and human oversight should be expressed as system and organisational requirements. Examples include data minimisation, retention limits, separation of operational data from worker-evaluation data, understandable status and failure explanations, human override mechanisms and cybersecurity-by-design.

5. Build human oversight into normal operation. Human control should not be treated as an emergency-only feature. Interfaces and procedures should make clear what the system is doing, why it is doing it, when confidence is low and when human intervention is required.

6. Integrate workforce planning into the deployment roadmap. Worker acceptance cannot be secured by technical performance or safety certification alone. Communicate expected operational changes, explain how roles may evolve, define training and reskilling pathways and address credible job-security and professional-value concerns.

7. Validate incrementally under representative conditions. Move from controlled testing to progressively more representative environments. Use industrial users and operators to test not only robot performance, but also usability, handover, exception handling, maintenance, data practices and organisational fit.

8. Measure operational value, not only technical novelty. Industrial evidence should connect technical performance with productivity, quality, waste, safety, ergonomics, integration burden, training requirements and maintenance costs. This creates a more credible adoption and business case.

9. Document for users, integrators and maintainers. Open-source release is not sufficient by itself. Effective reuse requires installation guidance, dependency management, interfaces, supported configurations, examples, troubleshooting information, contribution processes and clearly assigned maintenance responsibilities.

10. Plan sustainability in advance. Long-term use depends on ownership clarity, access rights, release and maintenance responsibilities, community governance, industrial support pathways and resources for continued validation and evolution.

2. Lessons learnt from the AGIMUS experience

The lessons below are cross-cutting lessons supported by the sociotechnical evidence currently available for this synthesis.

The most difficult requirements often sit at technical–governance boundaries. Robustness and safety, privacy and data governance, transparency, accountability and human oversight require coordinated technical and organisational decisions. They cannot be postponed to a final compliance review.

Industrial users evaluate versatility through continuity and risk. Adaptability is valuable only when production continuity is protected. Downtime, unstable behaviour, difficult maintenance and unclear failure handling can outweigh the benefits of additional autonomy.

Workforce acceptance is a substantive deployment condition. The AGIMUS survey indicated that job security, changes in routine or role and perceived devaluation of human work can be stronger sources of resistance than physical safety concerns. These issues require concrete organisational responses, not communication alone.

Training is part of system implementation, not an afterthought. Training and comprehensive briefing were among the measures most strongly supported for acceptance. Effective deployment therefore requires operator-facing learning, clear role allocation and capability building alongside technical commissioning.

Open-source value depends on the surrounding ecosystem. Reusable code creates a foundation for knowledge transfer, but sustainable uptake also requires documentation, issue handling, contribution governance, validation, compatibility support, training and long-term maintenance.

Industrial validation must produce reusable evidence. Demonstrations become more valuable when they generate evidence on repeatability, recovery, integration effort, safety, workload and maintenance — evidence that can be transferred to future applications and adopters.

Evidence must be interpreted in its temporal context. The 2023 survey provides a useful baseline, but stakeholder attitudes, regulation, standards and technology evolve. Longitudinal comparison is preferable to treating a single survey as a permanent market assessment.

WP6 pilot lessons

Platform independence strengthens resilience during industrial validation. The AGIMUS experience showed that a common software framework that can be transferred across different robotic platforms can preserve progress when a specific hardware platform is delayed or unavailable. This flexibility enabled continued integration, testing and evaluation across several robotic systems without fundamental changes to the overall architecture.

Progressive integration reduces deployment risk. Complex robotic systems benefit from incremental validation of components and complete task pipelines, moving from simulation and controlled testing environments towards end-to-end physical deployment. This allows integration issues to be identified earlier and limits the number of interacting variables introduced at each stage.

Achieving industrial readiness builds on technical excellence and successful system-level integration. The pilot experience showed that deployment performance depends on the effective interaction of perception, calibration, planning, control, end-effectors and robotic hardware. Integrated testing is therefore essential for identifying remaining limitations and prioritising the improvements needed for robust industrial deployment.

3. Recommendations by stakeholder group

The AGIMUS evidence base leads to different, but complementary, recommendations for technology developers, industrial adopters and integrators, policymakers and funders, and the open-source robotics ecosystem.

Researchers and technology developers

- Use deployment-relevant metrics alongside algorithmic metrics: repeatability, fault recovery, integration effort, maintenance burden, operator workload and safe fallback behaviour.
- Treat explainability, usability, maintainability, data governance and human oversight as first-order design objectives.
- Design for portability across robotic platforms through clear, stable interfaces and limited platform-specific dependencies, and validate portability early enough to provide alternative deployment pathways when hardware constraints arise.
- Design demonstrations around realistic variability, disturbances and exception cases rather than idealised task execution.
- Validate complete system performance alongside individual components, using diagnostic KPIs that make bottlenecks across perception, calibration, planning, control and manipulation visible.
- Publish sufficient documentation and examples to make open-source outputs practically reusable.
- Plan for the continuity of valuable open-source assets beyond project end, including their maintenance, further development and transfer to sustainable community or governance structures where appropriate.

Industrial adopters and system integrators

- Begin with an organisational and technical readiness assessment, including legacy infrastructure, data flows, workforce capabilities and maintenance capacity.
- Use staged integration and validation, progressing from simulation and controlled testing to complete end-to-end physical workflows, with explicit acceptance criteria before moving to the next deployment stage.

- Treat integration time and deployment logistics as explicit elements of pilot planning. Account early for hardware maturity, installation and calibration effort, transport constraints, site access and viable fallback configurations or testing environments.
- Include workforce communication, training, reskilling, data-use rules and role-transition planning in the deployment roadmap.
- Build the business case around total implementation and operating implications, not only projected productivity gains.
- Plan post-deployment monitoring, maintenance and responsibility for software and model updates.

Policymakers and research funders

- Couple technical robotics innovation with requirements for human-centric deployment, trustworthy AI governance and workforce transition.
- Encourage projects to report integration readiness, maintainability, acceptance, data governance and post-deployment monitoring alongside technical performance.
- Support reusable open-source infrastructures, documentation and maintenance mechanisms rather than only one-off demonstrators.
- Promote validation environments and cross-sector testbeds that allow evidence to be transferred between industrial applications.
- Support longitudinal evaluation so that persistent barriers can be distinguished from temporary perceptions or early-stage maturity effects.

Open-source ecosystem and post-project governance bodies

- Prioritise stable interfaces, versioning, documentation and reproducible installation paths.
- Use industrial feedback loops to prioritise robustness and interoperability improvements.
- Combine open software access with sustainable support, integration, validation, training and maintenance services.
- Maintain alignment between the technical roadmap, IP/access-right arrangements and the responsibilities of participating organisations throughout development and into post-project governance.
- Establish governance and maintenance arrangements early in the project lifecycle, including clearly identified maintainers, contribution rules, release processes and compatibility policies, so that continuity and synergies can be supported beyond project end.

4. Knowledge transfer and post-project use

AGIMUS best practices and recommendations can be linked to knowledge transfer and European excellence. Open-source software is one mechanism, but knowledge transfer also depends on documentation, training, reusable validation evidence, stakeholder networks and sustained technical stewardship.

Knowledge-transfer mechanism	Recommended practice
Open-source repositories	Keep releases, documentation, examples, dependencies, version history and contribution guidance accessible and maintained.
Data & research outputs	Use persistent repositories and clear metadata; preserve the context needed to interpret and reuse datasets responsibly.
Guidance	Translate project findings into concise, audience-specific deployment guidance, not only academic publications.
Training & workshops	Retain practical material for onboarding researchers, integrators and industrial users.
Industrial demonstrations	Document not only successes but also integration constraints, failure modes, adaptations and lessons that can transfer to new settings.
Community & governance	Maintain clear channels for technical coordination, user feedback, roadmap prioritisation and long-term responsibility.

5. Conclusion

AGIMUS demonstrates that the path from advanced robotics research to industrial uptake is not defined by autonomy or algorithmic performance alone. Versatile robotics must operate as part of a wider production and organisational system. Reliability, maintainability, integration readiness, safety, data governance, transparency, human oversight and workforce acceptance must therefore be managed together.

The best practices and recommendations in this whitepaper provide a reusable framework for future AI-powered robotics initiatives. Their purpose is not to prescribe a single technical architecture or deployment model, but to ensure that development and adoption decisions are made against the full set of conditions that determine whether a robotic system can be trusted, integrated, operated and sustained in real industrial environments.

In this sense, the AGIMUS contribution extends beyond individual algorithms and demonstrations: it provides transferable knowledge on how advanced robotic capabilities can be developed and deployed in a way that is technically credible, human-centred, operationally realistic and sustainable beyond the lifetime of a single research project.

Sources and further reading

[1] AGIMUS Grant Agreement No. 101070165, Part B. Horizon Europe project “Next generation of AI-powered robotics for agile production”.

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[4] AGIMUS semi-structured interviews. Zenodo. https://doi.org/10.5281/zenodo.10058708

[5] AGIMUS interviews with experts in AI ethics. Zenodo. https://doi.org/10.5281/zenodo.10059194

[6] AGIMUS D6.3 – Preparation, integration, and deployment of industrial pilots – Final Version.

[7] AGIMUS D6.5 – Cross Pilot Technical and Non-Technical Comparative Assessment – Final Version.

Scope note

This whitepaper synthesises the AGIMUS sociotechnical evidence together with relevant implementation, industrial pilot and exploitation-planning insights. It is intended as the project-level synthesis of best practices, lessons learnt and recommendations foreseen in the Grant Agreement.

Suggested citation

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